Grid Integration Strategy

Brian Parsons

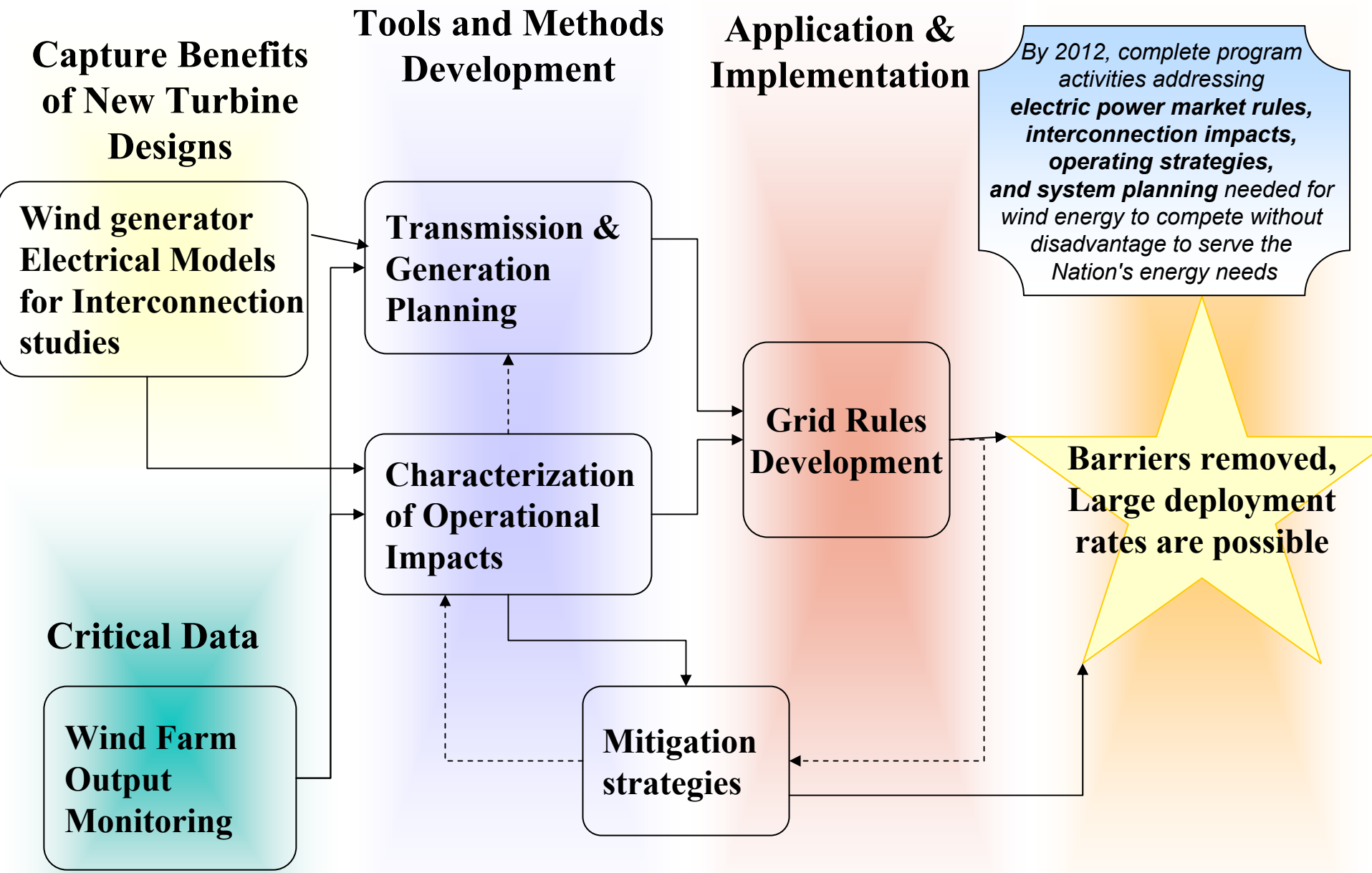
FY 2005 DOE Wind Program Implementation Meeting
November 16 -18, 2004
Omni Interlocken Hotel
Broomfield, Colorado

Acknowledgement

- Thanks for thought and work from Ed DeMeo, Charlie Smith, and Kevin Porter (plus translation to program documents by Tom Schweizer)
- Aim for strategic and targeted project direction
- Built on regionalized approach and new/strengthened alliances with UWIG, NWCC, regional transmission planning efforts, ISO's, control area operators, and other stakeholders
- Culminated in a September 14 session in Washington, D.C.

Wind Issues in the Grid Context

- Favorable economics and growing policy push, large potential in near term, new technology, unknown characteristics (natural reluctance)
- Key Issues
  - Interconnection requests: voltage stability, dynamic response (need models)
  - Dealing with variability: how much, geographic diversity, additional system costs, tariffs, reserve needs
  - Reliability value (capacity credit), generation planning
  - Transmission expansion planning
- Variability in Utility Organizational and Market Structure
  - RTO's/control areas
  - Vertically integrated or separate transmission and generation
  - Ownership and oversight



System Integration Relationships

System Integration Goal

- Ensure that wind energy can compete without disadvantage in serving the nation's energy needs
  - Actual interconnection impacts understood
  - Unbiased electric-power market rules
  - Broadly optimized operating strategies
  - Broadly optimized system planning (generation and transmission)

Overarching Objectives

- Ensure adoption of equitable grid-access and operational rules for wind in all major regional wind markets
- Ensure wind's needs and characteristics are considered in regional transmission-planning processes
- Enhance wind's compatibility with the nation's energy needs in the long term

Rationale

- Wind is new to power-system personnel. It challenges traditional planning and operating procedures. Natural instinct is to avoid it.
- Publicly funded activities are needed to overcome natural resistance to change and ensure realization of wind's prospective public benefits.
  - Objective, third-party technical source
  - Foundational analysis tools, methods, and verification
  - Otherwise unavailable data
  - Targeted regional assistance and outreach

Strategy

- Utilize partnership with UWIG and NWCC to engage with regional electric-system planning and operations personnel
- Ensure informed decisions about wind energy integration
  - Communicate wind-plant operating characteristics
    - Technology characterization and data collection
  - Influence power-system operation and expansion
    - Tools and methods development
  - Facilitate power-system access and impacts mitigation
    - Application and implementation
- Formalize feedback on priorities from regional entities

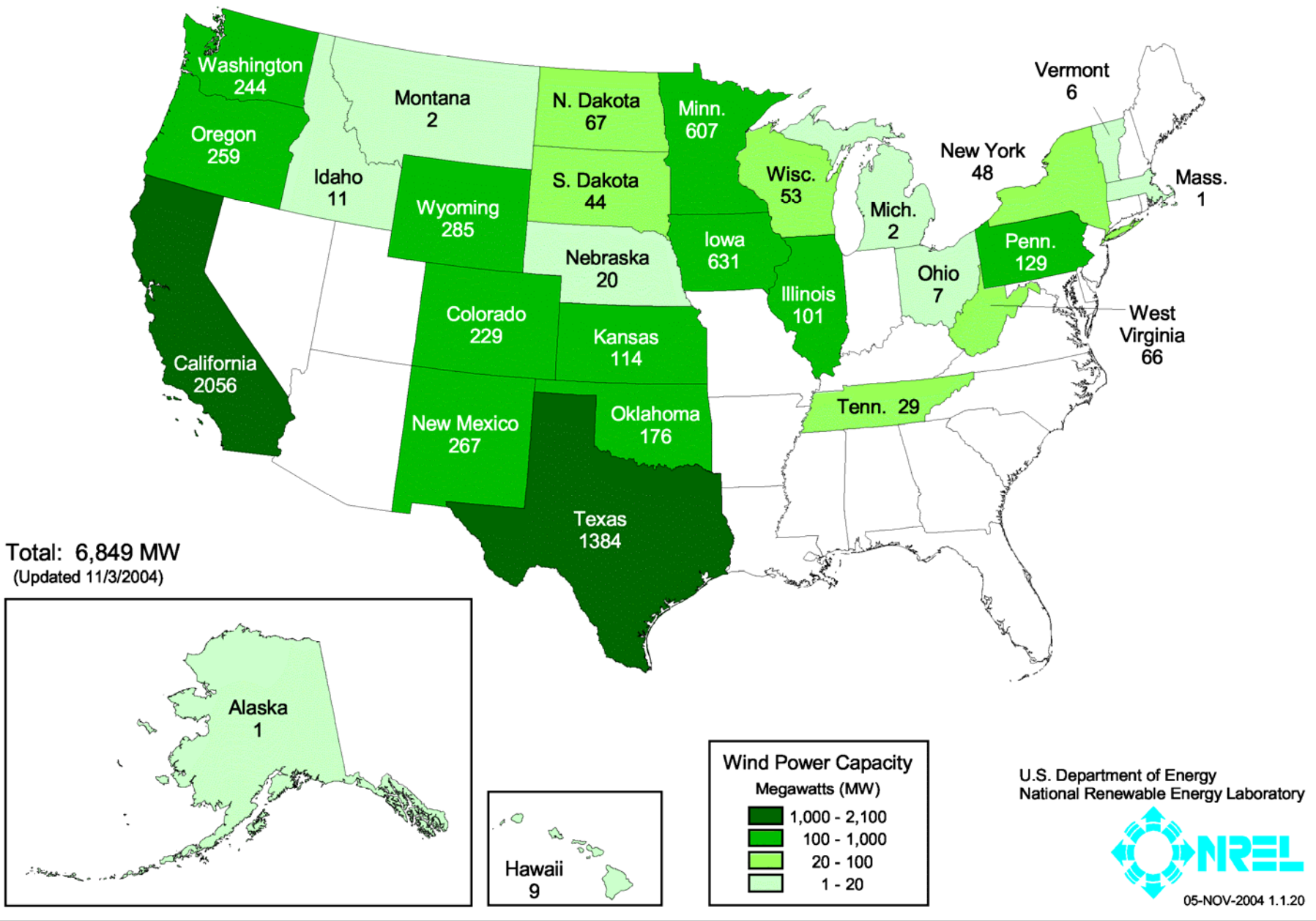
UWIG User Groups – Key Technical Interaction

- Operating Impact and Integration Studies
- Distributed Wind Applications
- Wind Plant Modeling and Interconnection
- Market Operation and Transmission Policy

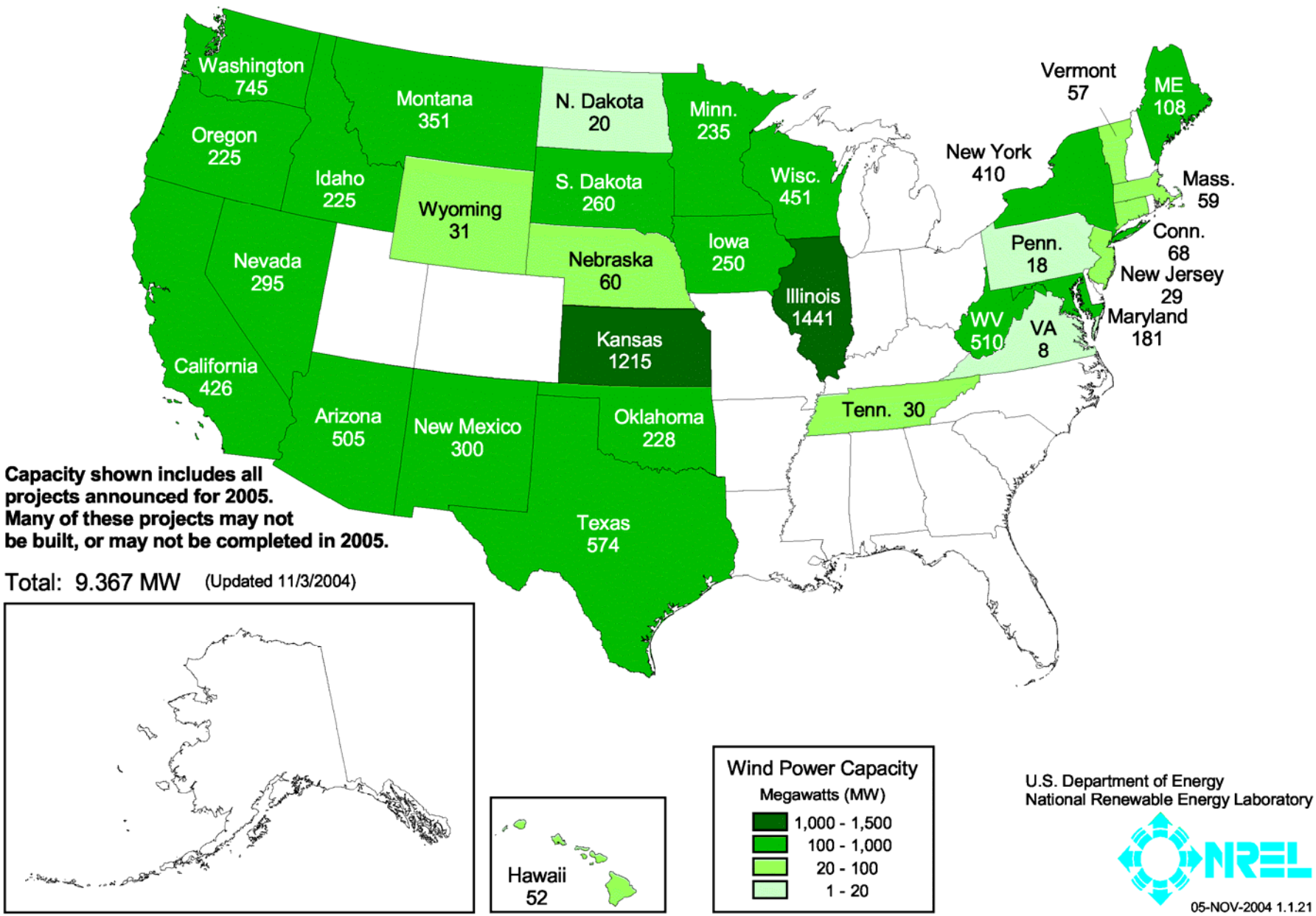
Best Practices

UWIG
Utility Wind Interest Group

United States - 2004 Expected Year End Wind Power Capacity (MW)



United States - Announced Wind Projects for 2005



Capacity shown includes all projects announced for 2005. Many of these projects may not be built, or may not be completed in 2005.

Total: 9.367 MW (Updated 11/3/2004)

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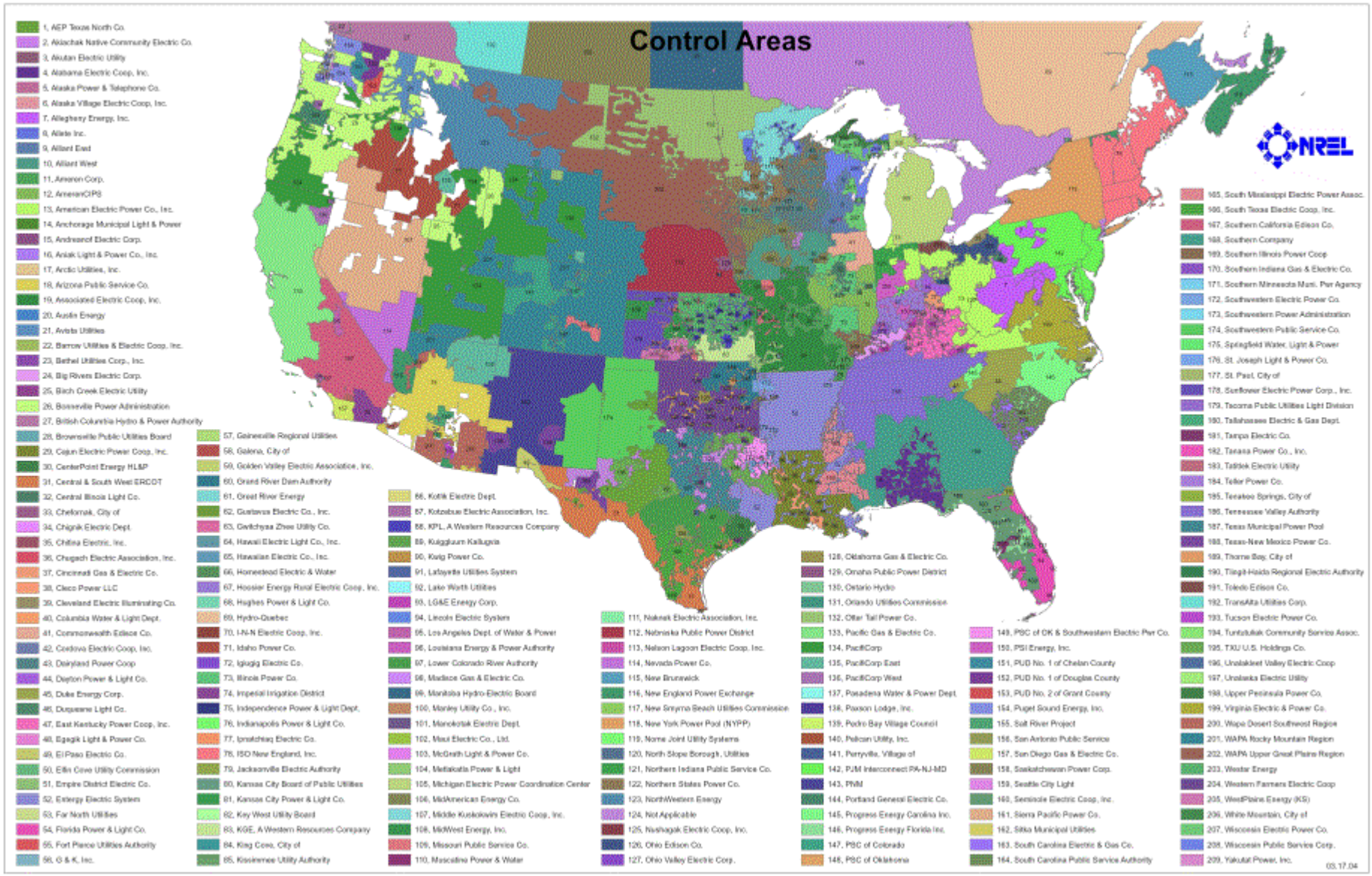
Control Areas
1, AEP Texas North Co.
2, Alaschak Native Community Electric Co.
3, Akutan Electric Utility
4, Alabama Electric Coop, Inc.
5, Alaska Power & Telephone Co.
6, Alaska Village Electric Coop, Inc.
7, Allegheny Energy, Inc.
8, Allete Inc.
9, Alliant East
10, Alliant West
11, Ameren Corp.
12, AmerenCIPS
13, American Electric Power Co., Inc.
14, Anchorage Municipal Light & Power
15, Andreanof Electric Corp.
16, Aniak Light & Power Co., Inc.
17, Arctic Utilities, Inc.
18, Arizona Public Service Co.
19, Associated Electric Coop, Inc.
20, Austin Energy
21, Avista Utilities
22, Barrow Utilities & Electric Coop, Inc.
23, Bethel Utilities Corp., Inc.
24, Big Rivers Electric Corp.
25, Birch Creek Electric Utility
26, Bonneville Power Administration
27, British Columbia Hydro & Power Authority
28, Brownsville Public Utilities Board
29, Cajun Electric Power Coop, Inc.
30, CenterPoint Energy HL&P
31, Central & South West ERCOT
32, Central Illinois Light Co.
33, Chelomak, City of
34, Chignik Electric Dept.
35, Chitina Electric, Inc.
36, Chugach Electric Association, Inc.
37, Cincinnati Gas & Electric Co.
38, Cleco Power LLC
39, Cleveland Electric Illuminating Co.
40, Columbia Water & Light Dept.
41, Commonwealth Edison Co.
42, Cordova Electric Coop, Inc.
43, Dairyland Power Coop
44, Dayton Power & Light Co.
45, Duke Energy Corp.
46, Duquesne Light Co.
47, East Kentucky Power Coop, Inc.
48, Egegik Light & Power Co.
49, El Paso Electric Co.
50, Elfin Cove Utility Commission
51, Empire District Electric Co.
52, Entergy Electric System
53, Far North Utilities
54, Florida Power & Light Co.
55, Fort Pierce Utilities Authority
56, G & K, Inc.
57, Gainesville Regional Utilities
58, Galena, City of
59, Golden Valley Electric Association, Inc.
60, Grand River Dam Authority
61, Great River Energy
62, Gustavus Electric Co., Inc.
63, Gwitchyaa Zhee Utility Co.
64, Hawaii Electric Light Co., Inc.
65, Hawaiian Electric Co., Inc.
66, Homestead Electric & Water
67, Hoosier Energy Rural Electric Coop, Inc.
68, Hughes Power & Light Co.
69, Hydro-Quebec
70, I-N-N Electric Coop, Inc.
71, Idaho Power Co.
72, Igiugig Electric Co.
73, Illinois Power Co.
74, Imperial Irrigation District
75, Independence Power & Light Dept.
76, Indianapolis Power & Light Co.
77, Ipnatchiaq Electric Co.
78, ISO New England, Inc.
79, Jacksonville Electric Authority
80, Kansas City Board of Public Utilities
81, Kansas City Power & Light Co.
82, Key West Utility Board
83, KGE, A Western Resources Company
84, King Cove, City of
85, Kissimmee Utility Authority
86, Kotlik Electric Dept.
87, Kotzebue Electric Association, Inc.
88, KPL, A Western Resources Company
89, Kuigpluum Kallugvia
90, Kwig Power Co.
91, Lafayette Utilities System
92, Lake Worth Utilities
93, LG&E Energy Corp.
94, Lincoln Electric System
95, Los Angeles Dept. of Water & Power
96, Louisiana Energy & Power Authority
97, Lower Colorado River Authority
98, Madison Gas & Electric Co.
99, Manitoba Hydro-Electric Board
100, Manley Utility Co., Inc.
101, Manokotak Electric Dept.
102, Maui Electric Co., Ltd.
103, McGrath Light & Power Co.
104, Metlakatla Power & Light
105, Michigan Electric Power Coordination Center
106, MidAmerican Energy Co.
107, Middle Kuskokwim Electric Coop, Inc.
108, MidWest Energy, Inc.
109, Missouri Public Service Co.
110, Muscatine Power & Water
111, Naknek Electric Association, Inc.
112, Nebraska Public Power District
113, Nelson Lagoon Electric Coop, Inc.
114, Nevada Power Co.
115, New Brunswick
116, New England Power Exchange
117, New Smyrna Beach Utilities Commission
118, New York Power Pool (NYPP)
119, Nome Joint Utility Systems
120, North Slope Borough, Utilities
121, Northern Indiana Public Service Co.
122, Northern States Power Co.
123, NorthWestern Energy
124, Not Applicable
125, Nushagak Electric Coop, Inc.
126, Ohio Edison Co.
127, Ohio Valley Electric Corp.
128, Oklahoma Gas & Electric Co.
129, Omaha Public Power District
130, Ontario Hydro
131, Orlando Utilities Commission
132, Otter Tail Power Co.
133, Pacific Gas & Electric Co.
134, PacifiCorp
135, PacifiCorp East
136, PacifiCorp West
137, Pasadena Water & Power Dept.
138, Paxson Lodge, Inc.
139, Pedro Bay Village Council
140, Pelican Utility, Inc.
141, Perryville, Village of
142, PJM Interconnect PA-NJ-MD
143, PNM
144, Portland General Electric Co.
145, Progress Energy Carolina Inc.
146, Progress Energy Florida Inc.
147, PSC of Colorado
148, PSC of Oklahoma
149, PSC of OK & Southwestern Electric Pwr Co.
150, PSI Energy, Inc.
151, PUD No. 1 of Chelan County
152, PUD No. 1 of Douglas County
153, PUD No. 2 of Grant County
154, Puget Sound Energy, Inc.
155, Salt River Project
156, San Antonio Public Service
157, San Diego Gas & Electric Co.
158, Saskatchewan Power Corp.
159, Seattle City Light
160, Seminole Electric Coop, Inc.
161, Sierra Pacific Power Co.
162, Sitka Municipal Utilities
163, South Carolina Electric & Gas Co.
164, South Carolina Public Service Authority
165, South Mississippi Electric Power Assoc.
166, South Texas Electric Coop, Inc.
167, Southern California Edison Co.
168, Southern Company
169, Southern Illinois Power Coop
170, Southern Indiana Gas & Electric Co.
171, Southern Minnesota Muni. Pwr Agency
172, Southwestern Electric Power Co.
173, Southwestern Power Administration
174, Southwestern Public Service Co.
175, Springfield Water, Light & Power
176, St. Joseph Light & Power Co.
177, St. Paul, City of
178, Sunflower Electric Power Corp., Inc.
179, Tacoma Public Utilities Light Division
180, Tallahassee Electric & Gas Dept.
181, Tampa Electric Co.
182, Tanana Power Co., Inc.
183, Tatitlek Electric Utility
184, Teller Power Co.
185, Texarkoo Springs, City of
186, Tennessee Valley Authority
187, Texas Municipal Power Pool
188, Texas-New Mexico Power Co.
189, Thorne Bay, City of
190, Tlingit-Haida Regional Electric Authority
191, Toledo Edison Co.
192, TransAlta Utilities Corp.
193, Tucson Electric Power Co.
194, Tuntutuliak Community Service Assoc.
195, TXU U.S. Holdings Co.
196, Unalakleet Valley Electric Coop
197, Unalaska Electric Utility
198, Upper Peninsula Power Co.
199, Virginia Electric & Power Co.
200, Wapa Desert Southwest Region
201, WAPA Rocky Mountain Region
202, WAPA Upper Great Plains Region
203, Westar Energy
204, Western Farmers Electric Coop
205, WestPlains Energy (KS)
206, White Mountain, City of
207, Wisconsin Electric Power Co.
208, Wisconsin Public Service Corp.
209, Yakutat Power, Inc.
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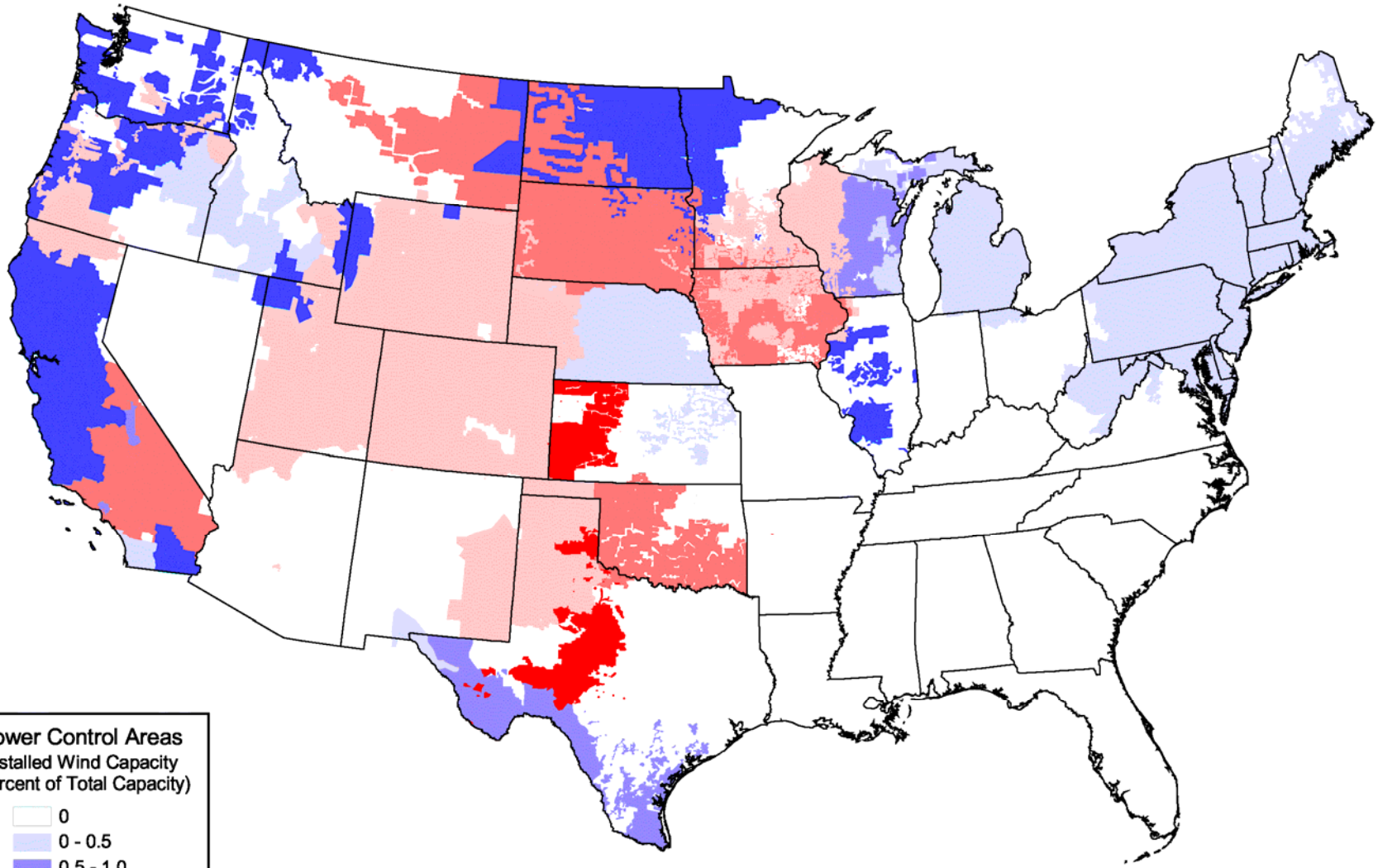
http://www.ferc.gov/industries/electric/indus-act/rto/rto-map.asp

Percent of Installed Nameplate Capacity from Wind by Control Area



Power Control Areas
Installed Wind Capacity
(Percent of Total Capacity)

- 0
- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- 5.0 - 10.0
- 10.0 - 53.5

Source: POWERmap and POWERdat, © 2004 Platts, a Division of the McGraw-Hill Companies.

Installed capacity assigned based on power plant locations relative to control area boundaries.

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Regional Activities: How to Prioritize?

- Quality of wind resource
- Presence (or lack of) supportive stakeholders—Cuts Both Ways
  - Presence of supportive stakeholders may make it easier to conduct activities, *but* could be duplicative and inefficient
  - Lack of stakeholders may indicate need for system integration activities, *but* could be difficult to sustain without some stakeholder support and assistance
  - Answer may depend on local circumstances and perhaps on other factors listed here

Regional Activities: How to Prioritize?

- Potential impact of systems integration activities
  - Are there a number of planned wind projects that could benefit from system integration activities?
- Presence of important state policies influenced by wind integration issues
  - California RPS
  - New York RPS proceeding
  - Minnesota Renewable Energy Obligation

Regional Activities: How to Prioritize?

- Favorable market conditions
  - Does the region need electric capacity?
  - Is the region looking to diversify generating resources (e.g., beyond natural gas?)
- Robustness and scope of transmission planning process
  - Regional in scope, or utility-by-utility?
  - Reliability-based, or are economics-based transmission included?
  - Wind development scenarios examined?

Regional Activities: How to Prioritize?

- What analytical tools are being applied or could be applied?
  - Modeling of wind in system grid?
  - Capacity credit analysis
  - Determination of regulation costs from wind

Progress on Regional Wind System Intergration Efforts

(Kevin Porter's Interpretation)

August 2004

	ERCOT	California	Lower Midwest	Upper Midwest	Northwest	Southwest	PJM	New York	New England
Electric Power Market Rules									
Transmission Pricing									
Energy Imbalance									
Flexible Firm									
Market Rules									
Interconnection Impacts									
Queue Status									
Group Queue									
Who Pays?									
Operating Strategies									
Wind Modeling									
Capacity Credit									
Wind Forecasting									
Wind Integration Costs									
Ancillary Service Costs									
System Planning									
Regional Transmission Planning									
Wind/Scenario									
Economic Transmission									

Key
Complete
In Progress
Insufficient Progress
Not Applicable

Recommended Focus Regions

- Lower Midwest
- Upper Midwest
- Southwest
- Northwest
- No overarching activity in PJM, New York, New England or ERCOT, though some specific issues may warrant attention
- Formal regional feedback will be solicited at appropriate forums (NWCC Sacramento, February)

Performance Measures

- Foundational analysis methods and tools available and accepted
- Market not held back by lack of performance data
- Program will provide region-by-region technical support in four areas:
  - Electric power market rulemaking
  - Interconnection impacts assessment
  - Tools development to guide operating strategies
  - Conduct of transmission-system planning
- Program will "lead the horse to water," but other stakeholders will need to "make the horse drink."
  - They will be highly motivated

Key Issue: Resources

- Continue to utilize strategic partnerships with UWIG, NWCC and many other region specific entities
- NREL hire status- pending
  - Early on, internally conflicted on level and focus
  - Settled on need for utility experience, analysis and outreach skills, focus a mid-grade level
  - Recent surge in applicants with applicable background
- Expanding use of students and interns has helped with workload

Conclusions

- Grid Integration strategy and rational well developed
- Research areas are driven by real-world needs
- Good internal and external team established, partnerships are critical
- Regional focus efforts are targeted and a feedback mechanism has been established
- Continual assessment of priorities needed